

A Review of the Southeast Asian Catfish Genus *Ceratoglanis* (Siluriformes: Siluridae), with the Description of a New Species from Thailand

OCT 25 1999

by

Ng Heok Hee

Department of Biological Sciences, National University of Singapore
10 Kent Ridge Crescent, Singapore 119260

The poorly-known Southeast Asian silurid genus *Ceratoglanis* is reviewed. Previously considered monotypic, a second species of *Ceratoglanis* from the southeastern Chao Phraya and Mekong drainages in mainland Southeast Asia is described here as *C. pachynema* new species. Previously unreported sexual dimorphism in the morphology of the pectoral spines and maxillary barbels is described.

The diverse Eurasian catfish family Siluridae includes nearly 100 extant nominal species, and is represented in Southeast Asia by putatively 18 genera (Bornbusch 1995), of which the genus *Ceratoglanis* Myers, 1938 comprises moderately large silurid catfishes (attaining standard lengths of up to 500 mm) found in large rivers. The genus has been recorded from mainland Southeast Asia, Java, Borneo and Sumatra and only one species is currently recognized, viz. *C. scleronema* (Bleeker, 1862). In reviewing the genus, it was found that specimens of *Ceratoglanis* from the Chao Phraya drainage, Thailand, previously assigned to *C. scleronema* represent a second, undescribed species here described as *C. pachynema* new species. This study also documents previously unrecorded sexual dimorphism in the shape of the maxillary barbels in *Ceratoglanis* species.

MATERIALS AND METHODS

Measurements were made point to point with dial calipers and data recorded to tenths of a millimeter. Counts and measurements were made on the left side of specimens whenever possible. Subunits of the head are presented as proportions of head length (HL). Head length and measurements of body parts are given as proportions of standard length (SL). Measurements and counts were made following Ng and Ng (1998). The ventral angle of the snout is taken as the angle between a vertical line passing through the tip of the snout and the tangent of the ventral half of the upper jaw (Fig. 1). This angle was measured from drawings of the lateral views of the heads.

Fin-ray counts were obtained under a binocular dissecting microscope using transmitted light. Numbers in parentheses following a particular fin-ray, branchiostegal-ray or gill-raker count are the numbers of examined specimens with that count. Vertebral counts were taken from radiographs following the method of Roberts (1994). Numbers in parentheses following a particular vertebral count are the numbers of radiographed specimens with that count.

Drawings of the specimens were made with a Nikon SMZ-10 microscopic camera lucida. Institutional codes follow Eschmeyer (1998). A listing of the material examined for this study can be found under the accounts of the appropriate species.

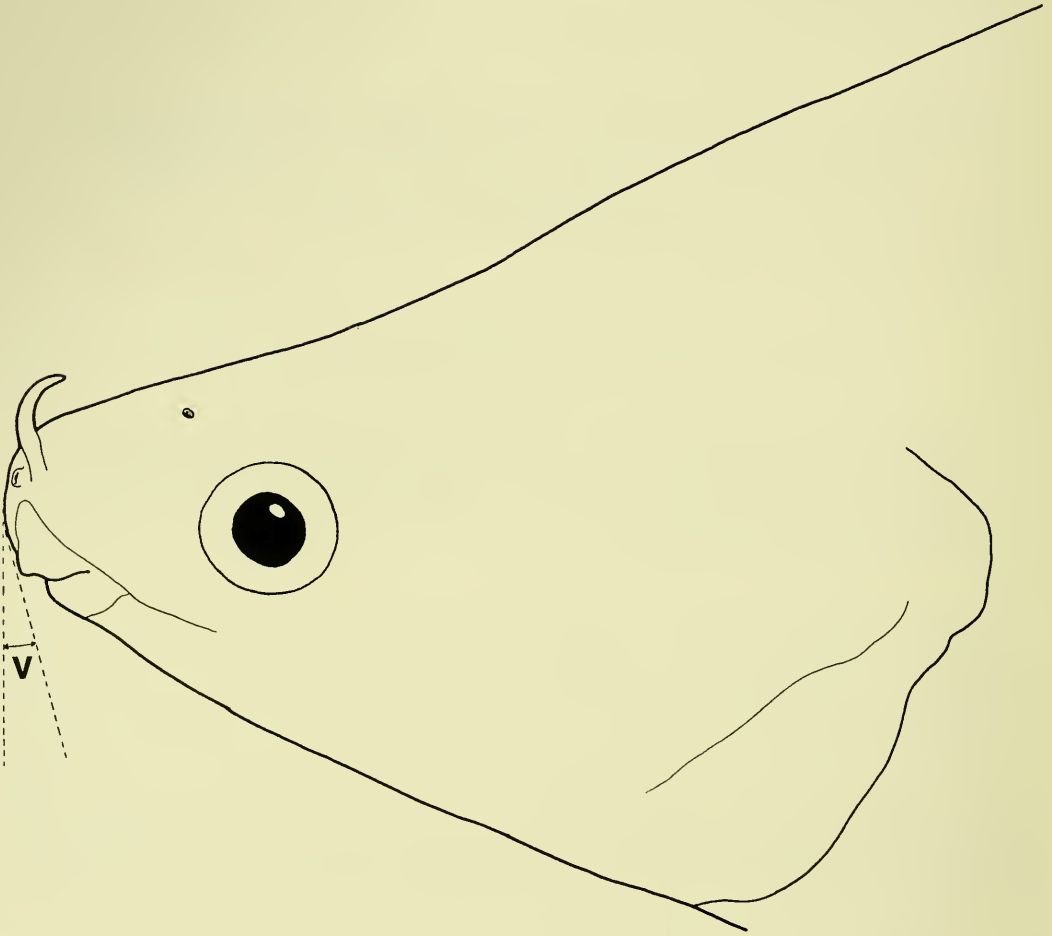


FIGURE 1. Lateral view of head of *Ceratoglanis*, showing how the ventral angle (v) of the snout is measured.

SPECIES DESCRIPTIONS

Ceratoglanis Myers, 1938

Ceratoglanis Myers 1938:98; Haig, 1952:65, 95; Roberts, 1989:144.

Hemisilurus (in part) Bleeker, 1862:93; 1863a:116; Weber and de Beaufort, 1913:210.

TYPE SPECIES. — *Hemisilurus scleronema* Bleeker 1862, by original designation and monotypy.

DIAGNOSIS. — *Ceratoglanis* is characterized by a combination of the following apomorphies (after Bornbusch and Lundberg 1989): (1) snout enlarged and bulbous, extending beyond gape; mouth subterminal; (2) posterior ramus of fourth transverse process broadly expanded by lamina that extends onto anterior ramus, rami separated by small indentation; (3) mandibular sensory canal enlarged in angular articular and dentary; and (4) maxillary barbel short, stiffened by cartilaginous rod, tip of barbel retrorsely hooked.

REMARKS. — *Ceratoglanis* and *Hemisilurus* are sister groups that comprise a monophyletic group within the Siluridae (Bornbusch and Lundberg 1987; Bornbusch 1995) and possess the first three synapomorphies listed above.

Ceratoglanis shows the typical sexual dimorphism in the pectoral spine and articulated segments reported in the silurid genera *Hemisilurus* by Bornbusch and Lundberg (1989), *Ompok* by Inger and Chin (1962), *Pterocryptis* by Bornbusch (1991), *Silurichthys* by Ng and Ng (1998) and *Silurus* by Kobayakawa (1989). The males have distinct serrations on the pectoral spine and the articulated segments; in females the serrations are either very small and indistinct, or are absent altogether. In addition, *Ceratoglanis* also exhibits sexual dimorphism in the shape of the maxillary barbels (previously only known in *Hemisilurus*, its sister taxon), which is reported here for the first time. The males of *Ceratoglanis* have membranous extensions on the anterior and (in *C. pachynema*) the posterior edges of the maxillary barbels, whereas in the females, these extensions are smaller (in *C. pachynema*) or absent (in *C. scleronema*). The role this dimorphism plays in the biology of *Ceratoglanis* is unclear.

The historical biogeography of the two *Ceratoglanis* species is probably similar to that proposed for *Hemisilurus moolenburghi* + *H. mekongensis* lineage by Bornbusch and Lundberg (1989), i.e., during the Pleistocene, the ancestral *Ceratoglanis* was dispersed throughout the North Sunda River system (to occupy branches in Borneo and Sumatra) and the South Indo-China River system. Post-Pleistocene isolations of the two river systems then led to the divergence of the two species.

***Ceratoglanis scleronema* (Bleeker, 1862)**

Figs. 2, 5a, 6a–b

Hemisilurus scleronema Bleeker, 1862:93, pl. 101 (type locality: Krawang, Java); 1863b:370; 1863c:74; Weber and de Beaufort, 1913:214, fig. 86; Hardenberg, 1934:306.



FIGURE 2. *Ceratoglanis scleronema*, ZRC 41896, 196.0 mm SL; Sumatra: Batang Hari basin.

Ceratoglanis scleronema Boulenger, 1894:247; Vaillant, 1902:49; Haig, 1952:65, 95; Tweedie, 1952:84; Imaki et al., 1981:40, fig. 69; Zakaria-Ismail, 1984:25; Bornbusch and Lundberg, 1989:441 (in part); Roberts, 1989:144; Kottelat et al., 1993:68, pl. 32 (in part); Lim et al., 1993:7; Kottelat and Lim, 1995:239.

MATERIAL EXAMINED. — **Java:** RMNH 2918 (1, holotype, 352 mm SL) Krawang, Bleeker collection. **Borneo:** CAS 49387 (3, 228.4–331.2 mm SL) Kalimantan Barat, Sintang market, 19 Jul 1976, T. R. Roberts and S. Wirjoatmodjo. ZRC 30810 (2, 270.0–286.4 mm SL) Sarawak, Marudi market; 18–20 Jun 1994, M. Kottelat and T. Tan. ZRC 40037 (1, 440 mm SL) Kalimantan Selatan, Muara Teweh, Pasar Pendopo (fish market), 3–4 Jun 1996, H. H. Ng and O. Chia. ZRC 42654 (4, 236.7–290.7 mm SL) Kalimantan Barat, Kabupaten Sanggau, market at Sanggau (0°7.29'N, 110°35.94'E), 21–27 Apr 1998, H. H. Tan et al. ZRC 42739 (1, 343 mm SL) Sarawak, market in Kapit, 28 Feb–3 Mar 1998, H. H. Tan and R. Kerle. **Sumatra:** USNM 93287 (1, 356 mm SL) Riau, Mandau river, Siak, 10 Jan 1934, W. C. Abbott. ZMA 121.819 (1, 216.6 mm SL) Jambi, Batang Hari, 1909, P. H. Moolenburgh. ZRC 38981 (2, 158.1–379 mm SL) Jambi, Pasar Angso Duo (fish market), Jun 1995, P. K. L. Ng et al. ZRC 41531 (4, 340–420 mm SL) Jambi, Pasar Angso Duo (fish market), 23–29 Jul 1997, H. H. Tan and H. H. Ng. ZRC 41896 (1, 196.0 mm SL) Jambi, Pasar Angso Duo (fish market), 21–28 Nov 1996, H. H. Tan et al. **Peninsular Malaysia:** ZRC 11985 (1, 406 mm SL) locality and collector unknown.

DIAGNOSIS. — A species of *Ceratoglanis* having a snout with a steep ventral profile (ventral angle of snout 20°–26°), relatively more anal-fin rays (98–108), and smaller eyes (eye diameter 10.7–14.0 %HL) that are set further apart (interorbital distance 35.4–40.9 %HL). Mature males of this species have membranous extensions on only the anterior edge of the maxillary barbel.

DESCRIPTION. — Head and body laterally compressed. Dorsal profile slightly convex, rising steeply from origin of epaxial muscle on skull roof to dorsal-fin pterygiophore. Snout prominent and bulbous, with a steep ventral profile (ventral angle of snout 20°–26°).

Anterior pair of nostrils tubular and anteriomedial to base of maxillary barbel. Posterior pair of nostrils located between anterior border of eye and base of maxillary barbel.

Mouth subterminal; gape horizontal. Well-developed rictal fold present, consisting of large and fleshy upper lobe joined at corner of mouth with lower lobe, which is subtended by a submandibular groove.

Teeth villiform. Dentary teeth in slightly curved, elongate bands narrowing posteriorly, reaching from symphysis almost to mouth corners; premaxillary teeth in a single, slightly curved, rectangular band formed from the fusion of two similarly-shaped patches on both sides and an anterior median triangle patch. Vomerine teeth in two separate round patches.

Eyes small, subcutaneous; located in anterior half of head; visible dorsally, but not ventrally.

Gill membranes separate and overlapping, free from isthmus. Branchiostegal rays 9(9) or 10(4). Gill rakers short, $2 + 10 = 12(1)$ or $2 + 11 = 13(1)$.

Maxillary barbel short, stiffened by cartilaginous rod and retrorsely hooked. Membranous extensions on the anterior edge of the maxillary barbel present in males. Females with simple barbels without such membranous extensions.

Distal margin of pectoral fin broadly convex, with I,13,i (2), I,14 (5), I,14,i (1), I,15 (1), I,15,i (1) or I,16 (3) rays. Proximal two-thirds of first pectoral-fin element co-ossified into a spine without anterior and distal denticulations. Pectoral spine and articulated segments sexually dimorphic in mature individuals. Males with spine broad and somewhat flattened dorsoventrally, with 11–16 distinct posterior serrae, increasing in size distally; proximal articulated segments with 9–10 well-developed posterior serrae; distal-most segments have smaller serrae. Females or juveniles with spine slender and without serrae; proximal articulated segments with 6 minute posterior serrae, distal segments without serrae. Distal margin of pelvic fin convex, with i,7 (13) rays. Distal margin of anal fin straight, with 98(1), 99(1), 100(1), 101(1), 102(3), 104(2), 106(2), 107(1) or 108(1) rays; posterior

margin separate from caudal fin. Integument over anal fin thickened proximally for slightly more than half of ray lengths; fin-ray erector muscles extending along anterior edges of anal-fin rays. Caudal fin forked, lobes equal; principal rays 8/9 (13). Urogenital papillae of both sexes located immediately posterior to insertions of pelvic fins.

In %SL: head length 14.4–17.0, head width 7.9–9.9, head depth 8.9–10.6, preanal length 26.3–30.2, prepelvic length 23.3–27.6, prepectoral length 15.2–18.0, body depth at anus 15.6–20.4, depth of caudal peduncle 4.9–5.8, pectoral-spine length 6.9–9.1, pectoral-fin length 11.3–14.1, pelvic-fin length 4.0–6.0, length of anal-fin base 62.5–71.2, caudal-fin length 12.3–15.5; in %HL: snout length 27.2–31.9, interorbital distance 35.4–40.9, eye diameter 10.7–14.0. Vertebrae 12 + 50 = 62(1), 12 + 51 = 63(3), 12 + 52 = 64(3) or 12 + 53 = 65(1).

COLORATION.—Flanks and thickened integument over anal fin diffusely pigmented with scattered melanophores; a thin line of melanophores more densely concentrated along the distal edge of the thickened integument over anal fin. Dorsal surfaces and sides of head gray, with relatively dense aggregations of melanophores. Melanophores less dense ventral to level of the eye; ventral surfaces of head and belly unpigmented with scattered melanophores. Ventral surface of head slightly orange in life. Maxillary barbels unpigmented.

Interradial membrane of pectoral fin diffusely pigmented with gray, with black distal margin. Pelvic fin with interradial membrane diffusely pigmented with gray along margin. Anal fin with interradial membrane diffusely pigmented with gray along distal two-thirds, becoming denser along the distal edge. Interradial membranes of caudal-fin lobes diffusely pigmented with gray along distal three-quarters; melanophores absent from proximal quarter of lobes and particularly dense at tips of lobes.

DISTRIBUTION.—This species is known from the Citarum drainage in Java, the Batang Hari and Siak drainages in Sumatra, the Pahang drainage in Peninsular Malaysia and the Baram, Barito, Kapuas, and Rejang drainages in Borneo (Fig. 4).

REMARKS.—*Ceratoglanis scleronema* can be distinguished from *C. pachynema* in having a snout with a steep (vs. gently sloping) ventral profile (ventral angle of snout 20°–26° vs. 40°–42°, Fig. 5). Mature males of *C. scleronema* have a small membranous extension of the maxillary barbel which is present along the anterior edge of the barbel (vs. larger membranous extensions present along both the anterior and posterior edges of the barbel in *C. pachynema*; Fig. 6).

The single specimen examined from the Malay Peninsula (406 mm SL) differs from all other specimens examined from Sumatra, Java and Borneo in having the bony surface of the toothplates covered with transverse plicae and minute peglike teeth embedded in the plicae, with the teeth rather sparsely distributed throughout the toothplates (vs. bony surface of the toothplates exposed, with many densely-packed rows of villiform teeth). Furthermore, the vomerine toothplate of the specimen from Peninsular Malaysia is in the form of a single ovoid patch (vs. two, clearly separate, rounded patches in other specimens examined).

The differences in the morphology of the toothplates seem to indicate that the specimen from the Malay Peninsula is not conspecific with those from Sumatra, Java and Borneo. However, there are no other significant morphological differences between the specimen from the Malay Peninsula and those from Sumatra, Java and Borneo. Furthermore, no exact locality information exists for the specimen in question and the large size of the specimen raises the possibility that the differences observed might be due to ontogenetic changes. The largest specimen from Sumatra (ZRC 41531, 420 mm SL) lacks a plicate toothplate. We are not sure if all big specimens possess a plicate toothplate because we lack a large series of big specimens to fully understand ontogenetic changes in this species. Based on these arguments, it would be more prudent to tentatively consider the population from the Malay Peninsula as being conspecific with those from Sumatra, Java and Borneo, until more specimens from the Malay Peninsula are available.

Little is known about the biology of this species, but *C. scleronema* appears to be predatory in nature, feeding on aquatic invertebrates as do most other medium-sized silurids. Crabs (*Neorhynchoplax prima*; family Hymenosomatidae), isopods, insect remains and remains of a small fish were found in the stomach of a dissected specimen (ZRC 41531, 420 mm SL) from the Batang Hari drainage.

***Ceratoglanis pachynema* n. sp.**

Figs. 3, 5b, 6c–d

Ceratoglanis scleronema (non Bleeker) Smith, 1945:339; Suvatti, 1950:286; 1981:83; Bornbusch and Lundberg, 1989:441 (in part); Kottelat, 1989:14 (in part); Nabhitabhata, 1991:187; Kottelat et al., 1993:68 (in part); Vidthayanon et al., 1997:44.

Hemisilurus scleronema (non Bleeker) Smith, 1931:181; Suvatti, 1936:71.

TYPE MATERIAL. — HOLOTYPE: CAS 96577 (1, 266.9 mm SL) Thailand: Prachinburi market, 28 May 1991, T. R. Roberts. PARATYPES: CAS 92882 (1, 203.0 mm SL) Thailand: Prachinburi market, 8–10 Sep 1990, T. R. Roberts. CAS 94185 (1, 128.2 mm SL) Thailand: Prachinburi market, 4–7 Dec 1990, T. R. Roberts. CAS 96576 (2, 218.7–279.0 mm SL) Thailand: Prachinburi market, 8–10 Sep 1990, T. R. Roberts.

DIAGNOSIS. — A species of *Ceratoglanis* with a snout with a gently sloping ventral profile (ventral angle of snout 40° – 42°), relatively fewer anal-fin rays (90–101), and larger eyes (eye diameter 13.0–16.4 %HL) set more closely together (interorbital distance 33.7–36.6 %HL). Mature males of this species have membranous extensions on both the anterior and posterior edges of the maxillary barbel.



FIGURE 3. *Ceratoglanis pachynema*, CAS 96576, 218.7 mm SL; Thailand: Chao Phraya basin.

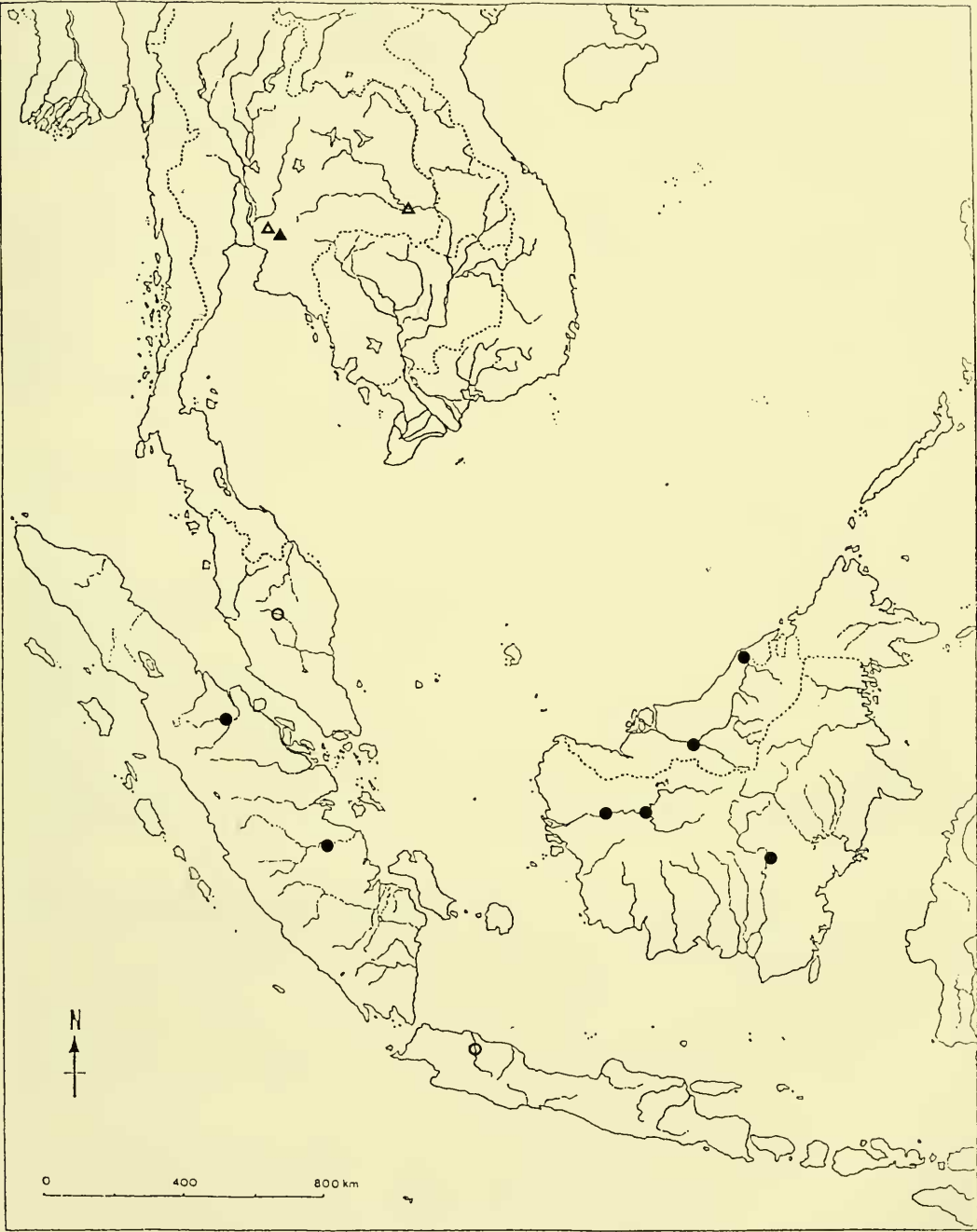


FIGURE 4. Map showing distribution of *Ceratoglanis* species: *C. scleronema* (●) and *C. pachynema* (▲). Open symbols indicate records from literature.

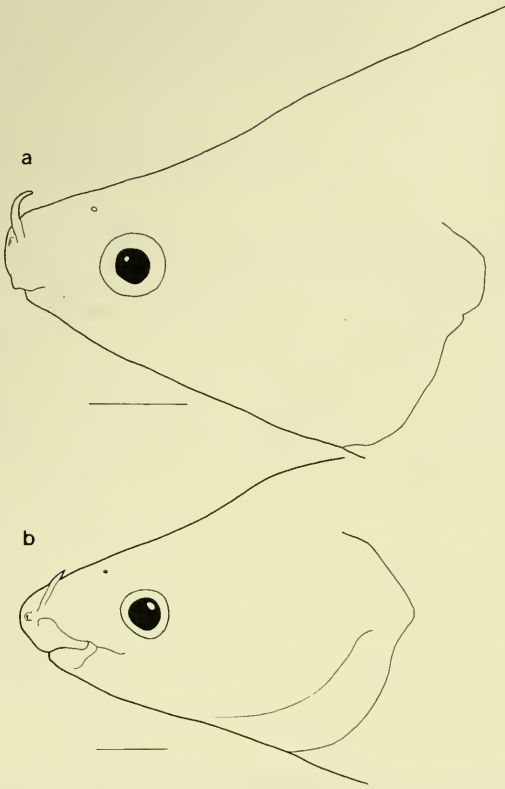


FIGURE 5. Schematic illustration of the lateral views of heads of a) *Ceratoglanis scleronema*, ZRC 38010, 286.4 mm SL; b) *C. pachynema*, paratype, CAS 94185, 128.2 mm SL. Scale bar = 10 mm.

Maxillary barbel short, stiffened by cartilaginous rod and retrorsely hooked. Membranous extensions on the anterior and posterior edges of the maxillary barbel present in males. Females with simple barbels having smaller extensions on the anterior edges of the maxillary barbels.

Distal margin of pectoral fin broadly convex, with 1,14 (3), 1,15 (1), 1,16 (1); pelvic i,7 (5) rays. Proximal two-thirds of first pectoral-fin element co-ossified into a spine without anterior and distal denticulations. Pectoral spine and articulated segments sexually dimorphic in mature individuals. Males with spine broad and somewhat flattened dorsoventrally, with 10 distinct posterior serrae, increasing in size distally; proximal articulated segments with 17 well-developed posterior serrae; distal-most segments have smaller serrae. Females or juveniles with spine slender and without serrae; proximal articulated segments with 6 minute posterior serrae, distal segments with 5 minute serrae. Distal margin of pelvic fin convex, with i,7 (5) rays. Distal margin of anal fin straight, with 90(1), 96(1), 97(1), 98(1) or 101(1) rays; separate from caudal fin. Integument over anal fin thickened proximally for slightly more than half of ray lengths; fin-ray erector muscles extending along anterior edges of anal-fin rays. Caudal fin forked, lobes equal; principal rays 8/8 (1) or 8/9 (4). Urogenital papillae of both sexes located immediately posterior to insertions of pelvic fins.

In %SL: head length 15.5–18.8, head width 8.8–11.7, head depth 9.9–13.1, preanal length 27.2–34.7, prepelvic length 24.3–31.0, prepectoral length 16.0–19.6, body depth at anus 16.4–22.3, depth of caudal peduncle 4.1–6.1, pectoral-spine length 8.2–10.8, pectoral-fin length 12.6–15.6,

DESCRIPTION. — Head and body laterally compressed. Dorsal profile slightly convex, rising steeply from origin of epaxial muscle on skull roof to dorsal-fin pterygiophore. Snout prominent and bulbous, with a gently sloping ventral profile (ventral angle of snout 40° – 42°).

Anterior pair of nostrils tubular and anterior-medial to base of maxillary barbel. Posterior pair of nostrils located between anterior border of eye and base of maxillary barbel.

Mouth subterminal; gape horizontal. Well-developed rictal fold present, consisting of large and fleshy upper lobe joined at corner of mouth with lower lobe, which is subtended by a submandibular groove.

Teeth villiform. Dentary teeth in slightly curved, elongate bands narrowing posteriorly, reaching from symphysis almost to mouth corners; premaxillary teeth in a single, slightly curved, rectangular band formed from the fusion of two similarly-shaped patches on both sides and an anterior median triangle patch. Vomerine teeth in two separate round patches.

Eyes small, subcutaneous; located in anterior half of head; visible dorsally, but not ventrally.

Gill membranes separate and overlapping, free from isthmus. Branchiostegal rays 9(1), 10(3) or 11(1). Gill rakers short, 1 + 10 = 11(1) or 2 + 11 = 13(1).

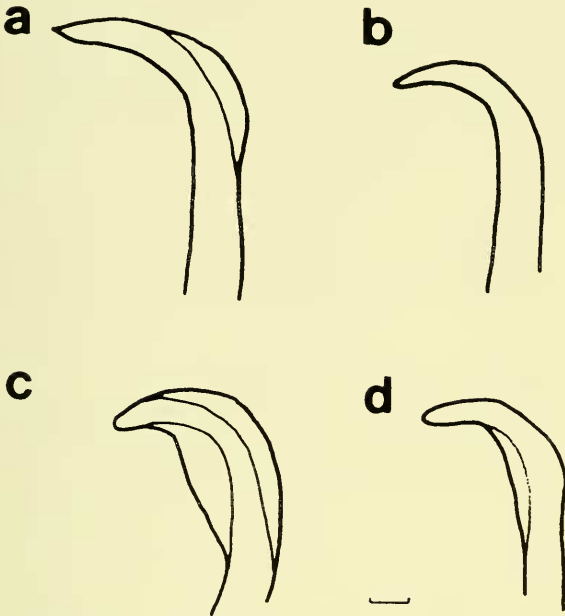


FIGURE 6. Schematic illustration of the maxillary barbels of: a) *Ceratoglanis scleronema*, male, ZRC 41531, 378 mm SL; b) *C. scleronema*, female, ZRC 41531, 336 mm SL; c) *C. pachynema*, male holotype, CAS 96577, 266.9 mm SL; d) *C. pachynema*, female paratype, CAS 96576, 218.7 mm SL. Scale bar = 1 mm.

pelvic-fin length 4.5–6.9, length of anal-fin base 63.7–68.3, caudal-fin length 11.9–15.3; in %HL: snout length 30.7–31.5, interorbital distance 33.7–36.6, eye diameter 14.0–16.4. Vertebrae $12 + 51 = 63(1)$, $13 + 50 = 63(3)$ or $12 + 52 = 64(1)$.

COLORATION. — Flanks and thickened integument over anal fin diffusely pigmented with scattered melanophores; a thin line of melanophores more densely concentrated along the distal edge of thickened integument over anal fin. Dorsal surfaces and sides of head gray, with relatively dense aggregations of melanophores. Melanophores less dense ventral to level of the eye; ventral surfaces of head and belly unpigmented with scattered melanophores. Maxillary barbels unpigmented.

Interradial membrane of pectoral fin diffusely pigmented with gray, with a black distal margin. Pelvic fin with interradial membrane diffusely pigmented with gray along margin. Anal fin with interradial membrane diffusely pigmented with gray along distal two-thirds, becoming denser along the distal edge. Interradial mem-

branes of caudal-fin lobes diffusely pigmented with gray along distal three-quarters; melanophores absent from proximal quarter of lobes and particularly dense at tips of lobes.

DISTRIBUTION. — This species is known from the southeastern part of the Chao Phraya drainage, and has been recorded from the Mekong drainage at Ubon Ratchathani by Nabhitabhata (1991) (Fig. 4).

ETYMOLOGY. — From *pachys*, Greek for thick and *nema*, Greek for thread, in reference to the thickened maxillary barbels of mature males.

REMARKS. — *Ceratoglanis pachynema* can be easily distinguished from *C. scleronema* in having a snout with a gently sloping (vs. steep) ventral profile (ventral angle of snout 40° – 42° vs. 20° – 26° ; Fig. 5). Mature males of *C. pachynema* also have large membranous extensions of the maxillary barbel present along both the anterior and posterior edges of the barbel (vs. a smaller membranous extension present only along the anterior edge of the barbel in *C. scleronema*; Fig. 6).

ACKNOWLEDGMENTS

I thank Carl Ferraris for commenting on the manuscript, and the following for the loan of material and permission to examine specimens under their care: William Eschmeyer and David Catania (CAS); Lynne Parenti (USNM); Isa c Isbr cker (ZMA); Yang Chang Man and Kelvin Lim (ZRC). I also thank Jon Fong (CAS) for providing radiographs of the specimens. Funding for this project was provided by a short-term visitor grant to the author from the Smithsonian Institution and research grant RP 960314 to Peter K. L. Ng from the National University of Singapore.

LITERATURE CITED

- BLEEKER, P. 1862. Atlas Ichthyologique des Indes Orientales Néerlandaises. Tome 2. Siluroïdes, Chacoïdes et Hétérobranchoïdes. Frederic Muller, Amsterdam. 112 pp., pls. 49–101.
- . 1863a. Systema silurorum revisum. Ned. Tijds. Dierk. 1:77–122.
- . 1863b. Description de trois espèces nouvelles de Siluroïdes del'Inde Archipélagique. Ned. Tijds. Dierk. 1:368–371.
- . 1863c. Description de trois espèces nouvelles de Siluroïdes del'Inde Archipélagique. Versl. Akad. Amsterdam 15:70–76.
- BORNBUSCH, A. H. 1991. Redescription and reclassification of the silurid catfish *Apodoglanis furnessi* Fowler (Siluriformes: Siluridae), with diagnoses of three intrafamilial silurid subgroups. Copeia 1991(4):1070–1084.
- . 1995. Phylogenetic relationships within the Eurasian catfish family Siluridae (Pisces: Siluriformes), with comments on generic validities and biogeography. Zool. J. Linn. Soc. 115:1–46.
- BORNBUSCH, A. H. AND J. G. LUNDBERG. 1989. A new species of *Hemisilurus* (Siluriformes, Siluridae) from the Mekong River, with comments on its relationships and historical biogeography. Copeia 1989(2):434–444.
- ESCHMEYER, W. 1998. Catalog of Fishes. California Academy of Sciences, San Francisco. 2905 pp.
- HAIG, J. 1952. Studies on the classification of the catfishes of the Oriental and Palaearctic family Siluridae. Rec. Indian Mus. 48:59–116.
- HARDENBERG, J. D. F. 1934. Additional notes to my paper "The fishfauna of the Rokan mouth." Treubia 14:299–312.
- IMAKI, A., A. KAWAMOTO, AND A. SUZUKI. 1981. Results of an ichthyological survey in the Kapuas river, west Kalimantan, Indonesia. Res. Inst. Evol. Biol. Sci. Rep. 1:33–54.
- INGER, R. F. AND P. K. CHIN. 1962. The freshwater fishes of North Borneo. Fieldiana: Zool. 45:1–268.
- KOBAYAKAWA, M. 1989. Systematic revision of the catfish genus *Silurus*, with description of a new species from Thailand and Burma. Japanese J. Ichthyol. 36:151–186.
- KOTTELAT, M. 1989. Zoogeography of the fishes from Indochinese inland waters with an annotated check-list. Bull. Zool. Mus. 12:1–55.
- KOTTELAT, M. AND K. K. P. LIM. 1995. Freshwater fishes of Sarawak and Brunei Darussalam: a preliminary annotated check-list. Sarawak Mus. J. 48:227–258.
- KOTTELAT, M., A. J. WHITTEN, S. N. KARTIKASARI, AND S. WIRJOATMODJO. 1993. Freshwater fishes of western Indonesia and Sulawesi. Periplus Editions, Hong Kong. 221 pp., 84 pls.
- LIM, K. K. P., P. K. L. NG, M. KOTTELAT, AND M. ZAKARIA-ISMAIL. 1993. A preliminary working list of native freshwater fishes of peninsular Malaysia. AWB Publication No. 94. Asian Wetlands Bureau, Kuala Lumpur. ii + 10 pp.
- MYERS, G. S. 1938. Notes on *Ansorgia*, *Clarisilurus*, *Wallago* and *Ceratoglanis*, four genera of African and Indo-Malayan catfishes. Copeia 1938(2):98.
- NABHITABHATA, J. 1991. Endangered species and habitats of Thailand. Ecological Research Department, Thailand Institute of Scientific and Technological Research. 241 pp.
- NG, H. H. AND P. K. L. NG. 1998. A revision of the South-east Asian catfish genus *Silurichthys*. J. Fish Biol. 52:291–333.
- ROBERTS, T. R. 1989. The freshwater fishes of Western Borneo (Kalimantan Barat, Indonesia). Mem. Calif. Acad. Sci. 14:1–210.
- . 1993. Just another dammed river? Negative impacts of Pak Mun Dam on fishes of the Mekong basin. Nat. Hist. Bull. Siam Soc. 41:105–133.
- SMITH, H. M. 1931. Notes on Siamese fishes. J. Siam Soc. Nat. Hist. Suppl. 8:177–190.
- . 1945. The freshwater fishes of Siam or Thailand. Bull. U.S. Natn. Mus. 188:1–622.
- SUVATTI, N. C. 1936. Index to the fishes of Siam. Bureau of Fisheries, Bangkok. 226 pp.
- . 1950. The fauna of Thailand. Department of Fisheries, Bangkok. ii + 1100 pp.
- . 1981. Fishes of Thailand. The Royal Institute, Thailand. 380 pp. [in Thai].
- TWEEDIE, M. W. F. 1952. Notes on Malayan fresh-water fishes. 3. The anabantoid fishes, 4. Some new and interesting records, 5. Malay names. Bull. Raffles Mus. 24:63–95.
- VAILLANT, L. 1902. Résultats zoologiques de l'expédition scientifique Néerlandaise au Bornéo Central. Notes Leyden Mus. 24:1–166, pls. 1–2.

- VIDTHAYANON, C., J. KARNASUTA, AND J. NABHITABHATA. 1997. Diversity of freshwater fishes in Thailand. Office of Environmental Policy and Planning, Bangkok. 102 pp.
- WEBER, M. AND L. F. DE BEAUFORT. 1913. The fishes of the Indo-Australian Archipelago. Vol. 2. Malacopterygii, Myctophoidea, Ostariophysi: 1. Siluroidea. E. J. Brill, Leiden. xx + 404 pp.
- ZAKARIA-ISMAIL, M. 1984. Checklist of fishes of Taman Negara. Malayan Nat. 37:21–26.